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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 7 : B21H 3/02, 3/04, 3/06 — A1

(11) International Publication Number: **WO 00/47349**

(43) International Publication Date: 17 August 2000 (17.08.00)

(21) International Application Number: PCT/AU00/00081

(22) International Filing Date: 9 February 2000 (09.02.00)

(30) Priority Data:

PP 8664	12 February 1999 (12.02.99)	AU
PP 9488	29 March 1999 (29.03.99)	AU

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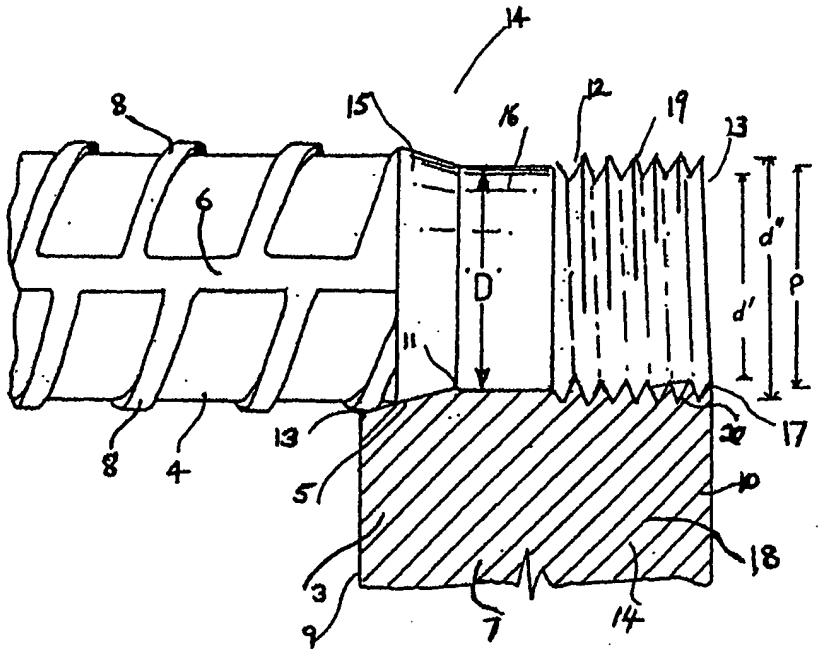
(81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published

With international search report.

(54) Title: METHOD FOR EXTERNALLY THREADING A DEFORMED BAR



(57) Abstract

A method of forming male threads on deformed metal bars (4) to form rock bolts is disclosed. The method involves removing the deformation from an end portion of the bar by a cold rolling process that reduces the diameter (1) of the end portion of the bar and then rolling a male thread (12) onto that portion of the bar.

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METHOD FOR EXTERNALLY THREADING A DEFORMED BAR

Field of the Invention

The present invention relates to a method of forming an external thread on an elongate member as well as to the member so threaded.

Background to the Invention

Externally or male threaded deformed metal bars are commonly used as the supporting shaft in rock bolts for anchoring the roof of mine tunnels. In this application the bar has a male thread on one end portion and the unthreaded end region of the bar is anchored, usually by a chemical adhesive, into the rock above the roof of the mine tunnel and a roof support plate is clamped against the mine tunnel roof by a nut engaged with the thread formed on the opposite end of the bar.

Many different deformation patterns of such bar are known. Some patterns are considered to provide enhanced bonding between the bar and the chemical adhesive or to assist in the mixing of the chemical adhesive with rotation of the bar during installation in a mine roof while minimising the formation of air bubbles known as cavitation, in the adhesive.

Various methods have been proposed to form the required thread on a deformed bar. One method has involved skimming the deformations from an end region of the bar in a metal removing process prior to the thread being formed by either cutting into that end region or using a cold rolling operation.

This method is not an efficient way of forming the thread as deformations and usually part of the underlying bar shaft are machined away to produce a diameter suitable for thread cutting or rolling. A second method is disclosed in US Patent 4,584,247 assigned to The Titan Manufacturing Co Pty Ltd. This method involves the cold rolling of the deformed bar to form a male thread. This process requires the bar selection to be made so that the average cross-sectional area of the bar with the formed thread is substantially equal to that of the unthreaded portions of the bar. This method also involves very high loads being placed on the thread forms of the rolls used in the rolling operation. In addition, there is a tendency for burrs to be formed on the resultant thread which is undesirable not only from a

thread quality point of view but also from safety aspects associated with handling of the threaded bar.

In this process a thread may be roll formed directly avoiding the need for a separate prior sizing process. However, the blank still needs to be provided so that the region on which the thread is formed has a reduced diameter, if the major diameter of the thread is to equal that of an adjacent region of the blank.

A further method of making rock bolts is described in US Patent No. 4,955,219 assigned to Videx-Wire Products (Proprietary) Limited. In this process the deformations are cold formed only on the sections of the bar that are not to be threaded. This method suffers from the disadvantage that the deformations able to be cold formed are more limited than those produced during the usual hot forming process.

Summary of the Invention

In one form this invention provides a method of forming an external thread along an elongate member comprising reducing the diameter of region towards one end of the member in a cold rolling operation to provide a cylindrical cross-section of predetermined diameter in that region, forming an external thread on the cylindrical cross-section of predetermined diameter by a cold rolling operation.

In another form this invention provides a method of forming an external thread along an elongate member, comprising:

reducing a diameter of a region of the member in a cold rolling operation that progresses along the member in a direction away from an end of said member and which rolling operation also involves rolling the thread onto the region of reduced diameter with the progression of the rolling operation along the member.

The reduction of the diameter of the member will typically involve the formation of a tapered region on the member that tapers in a direction toward said end of the member. The thread when formed will generally extend along the member in a direction from the end thereof and finish a distance from the tapered region.

The rolling operation may also involve driving the member between a plurality of rolls having thread forms for cold forming the thread on the member or

alternatively, driving the rolls along the member such that the member passes therebetween.

In another aspect there is provided a member with an external thread formed along a region of the member by the method of the invention as described above.

In still another aspect, there is also provided a roll adapted for reducing a diameter of a region of an elongate member and for subsequently cold rolling an external thread onto the region of reduced diameter so formed, the roll having a first end and an opposite second end, and:

a tapered region with a circumferentially extending outer surface for contact with the member, and which has a diameter that increases in a direction from the first end of the roll toward the opposite second end of the roll;

a thread forming region for forming the thread on the region of reduced diameter of the member, and

a second that spaces the tapered region from the thread forming region.

In a yet further aspect of the invention there is provided an arrangement for reducing an outer diameter of a region of an elongate member and cold rolling an external thread onto the region of reduced diameter so formed, comprising:

a plurality of rolls each having a first end and an opposite second end and being rotatable about an axis of rotation, respectively;

wherein the rolls are spaced apart to allow passage of the member between and alongside the rolls in a lengthwise direction of the member, and each roll has:

a tapered region with a circumferentially extending outer surface for contact with the member, and which has a diameter that increases in a direction from the first end of the roll toward to the opposite second end of the roll;

a thread forming region for forming the thread on the region of reduced diameter of the member, and

a section that spaces the tapered region from the thread forming region.

The member may be any elongate item on which it is desired to form a thread such as a bar, rod or shaft. The method of the invention finds particular application in the formation of threads in the manufacture of fasteners such as general purpose bolts,

and on deformed bars in the manufacture of rock bolts for anchoring the roofs of mine tunnels and the such like.

When a thread is formed on a member having protruding deformations such as those on a deformed bar, the deformations are rolled into the member as the diameter of the region of the member on which the thread is to be formed is reduced. Accordingly, the deformations on that region of the bar are removed and as a consequence, the exertion of high loads on the thread forms of the rolls such as occurs in the prior art in the instance where the deformations are not removed prior to the rolling of the thread, are avoided. This can lead to a substantially longer working life of the rolls and thereby achieve cost savings over time by reducing the frequency with which the rolls need to be replaced.

In addition, the method described herein enables the member to be sized and threaded in the one operation and so is efficient both in terms of the time involved and hence the cost of the threading process. Moreover, since the diameter is reduced and the thread formed by a rolling operation as distinct from sizing and rolling or cutting operations which involve the removal of material from the member being processed, the method is also efficient from the point of view that there is essentially no loss of material from the member as a result of the reduction of the diameter of the relevant section of the member nor the actual formation of the thread. In this invention the diameter that is reduced to form the cylindrical portion is, in the case of a deformed bar, inclusive of the deformations or ribs. Thus the first part of the rolling operation may effectively remove the deformations without changing the diameter of the core of the bar. However, this is still regarded as a reduction in diameter of the deformed bar.

The invention will be further described hereinafter with reference to a number of preferred embodiments illustrated in the accompanying drawings.

Brief Description of the Drawings

Figure 1 is a schematic view of a thread being formed on a member by a method of the invention; and

Figure 2 is a schematic view illustrating a thread with truncated crests formed on a member by a method of the invention.

Detailed Description of the Invention

A member in the form deformed steel bar 4 is illustrated in Fig. 1. The bar 4 is a known type having a deformation pattern formed by a pair of longitudinally extending and opposed ribs, one rib 6 of the pair being provided on the front side of the bar 4. The pattern also consists of a plurality of transverse ribs 8 that connect the pair of longitudinal ribs together. The bar 4 is in engagement with two substantially identical hardened die rolls 10 (only one is shown) arranged along opposite sides of the bar 4 and which act together to reshape the bar and form the thread 12 on the end region of bar 4. Each of the die rolls 10 has an axis of rotation that lie substantially parallel with the longitudinal axis of the bar and are rotated counter to each other.

The roll 10 has a frustoconical region 3 with a tapered surface 5 that tapers from a cylindrical section 7 of the roll to end 9 of the roll such that the diameter at the inner edge 11 of the frustoconical region is greater than that at the outer edge 13 of the frustoconical region. The angle of the taper is approximately 10°. The diameter of the roll is substantially constant along the cylindrical section. The roll also has a thread forming region 14 for forming the thread 12 on the deformed bar 4.

To form thread 12, the bar 4 is gripped in a chuck or by other suitable means and rotated about its longitudinal axis as it is driven into rolls 10 and such that the periphery of the end 23 of the bar is pressed into contact with the tapered surfaces 18 of the rolls. The bar is at ambient temperature and so is not heated prior to being processed.

With forced progression of the bar between the rolls, the end region 14 of the bar is progressively reshaped resulting in the diameter of the end region of the bar being reduced. The rolling operation also leads to the provision of tapered formation 15 on the bar. With yet further advancement of the bar 4 between the rolls, a cylindrical section 16 having diameter D is formed on the bar. The diameter D is substantially equal to the pitch circle diameter P of the thread 12 plus half the difference between the root diameter d' and the crest diameter d" of the thread.

As indicated in Fig. 1, the longitudinal and transverse ribs 6 and 8 forming the deformation pattern on the bar are rolled into the bar with progression of the bar between the rolls.

For the thread 12 to be formed it is simply a matter of further driving the bar 4 between the rolls 10 such that the cylindrical section 16 of the bar is forced into contact with thread formations 17 on thread forming region 18 of the rollers. The skilled addressee will appreciate that the rollers are restrained against lateral movement away from the bar during the processing of the bar. Any suitable method of rotatably mounting the rolls and restraining lateral movement may be used.

The thread 12 is not cut into the bar 4 but rather, is formed by displacement of steel comprising cylindrical section 16 of the bar by the action of thread formations 17 of the rolls. More particularly, steel displaced as the root of the thread is formed is displaced along the bar to form the crests of the thread. Accordingly, the thread formations 17 of the rollers play no part in reducing the diameter of the bar 4 prior to the forming of the thread 12 on the bar.

The method, therefore, enables removal of the deformations on the end region of the bar prior to the formation of the thread 12, both of which are achieved substantially without loss of any steel from the bar.

In some circumstances, it is desirable to form a thread in which the thread crests 19 are truncated such as where there is a high likelihood of dirt being caught in the thread as a result of environmental working conditions in use. The presence of dirt can inhibit the mating of threads as it takes up working clearance and jams between adjacent thread faces. Accordingly, the presence of dirt can lead to unacceptable difficulty when screwing threads together such as when a nut is screwed onto the thread 12 of bar 4.

By truncating the crests of a male thread 12, a space is formed between the crests of that thread and the valley of the female thread of the nut. Such a thread can be readily achieved with the instant method by increasing the diameter of the cylindrical section 7 of each roll 10 while maintaining the pitch circle diameter of the thread forming region 18 of the rolls the same. Thus, the diameter D of the cylindrical section 16 formed on the deformed bar will be reduced so that as the thread 12 is formed there is insufficient metal available to fill the valleys of the thread formations 17 on the rolls thereby causing the thread 12 to be formed with truncated crests 21. A

deformed bar having such a thread engaged with a female thread in a nut 27 is illustrated in Fig. 2.

Rather than driving the deformed bar 4 between rolls 10 the bar may be gripped and restrained against longitudinal movement, and the rolls driven along the sides of the bar to thereby form the thread. Accordingly, all that is required in order to form thread 12 is that there be relative movement between the bar and the rolls in the lengthwise direction of the bar with simultaneous rotation of the bar and the rolls.

In addition, rather than a pair of rolls, three or more rolls spaced around the circumference of the bar may be used to reduce the diameter of the bar and form the thread along the end region of the bar in the manner as described above.

In a particularly preferred embodiment, the thread formation on each roll may begin on its cylindrical section 7. In this instance, the thread formation on the cylindrical section 7 will be shallow and increase in depth until the full thread depth is achieved in the thread forming regions 27 of the rolls. The profile of the thread formations will also generally increase in definition along the cylindrical section of each roll. By initiating the formation of the thread 12 during contact with the cylindrical sections of the rolls, wear of the thread formations on the thread forming regions 18 of the rolls can be reduced.

From the foregoing it is apparent that the thread formations 17 on the rolls 10 do not have a role in the reduction of the diameter of the end region of the bar prior to the formation of the thread 12. As a consequence, it is possible with the present method to process deformed bar with a volume per unit length greater than that of cylindrical section 16 required for the rolling of the thread 12. This is quite different from the prior art method in which the deformations are rolled directly into the thread by the thread formations on the rolls used since in that method, the volume of the bar per unit length is substantially the same before and after the formation of the thread.

While the invention has been described with reference to the formation of a thread on a deformed bar, it will be appreciated that the method of the invention is not limited thereto and has broad application. More specifically, the method has application in the formation of external threads on any suitable member such as the shaft of a blank for a bolt or other fastener, and rods, bars and shafts in general.

Accordingly, the skilled addressee will understand that numerous variations and modifications are possible without departing from the scope of the invention.

Claims:

1. A method of forming an external thread along an elongate member, comprising:

reducing a diameter of a region of the member in a rolling operation that progresses along the member in a direction away from an end of the member and which rolling operation involves rolling the thread onto the region of reduced diameter with the progression of the rolling operation along the member.

2. A method according to claim 1 wherein the rolling operation involves forming a tapered region on the member, the tapered region having a diameter that decreases along the bar in a direction toward the end of the member.

3. A method according to claim 2 wherein the thread when formed extends away from the end of the member and finishes a distance from the tapered region of the member.

4. A method according to any one of claims 1 to 3 wherein a single set of rolls lying alongside and distanced apart from each other are used in the rolling operation , and each roll of the set acts to reduce the outer diameter of the region of the bar and to roll the thread onto the member.

5. A method according to claim 4 wherein the reduction of the outer diameter of said region of the bar and the forming of the thread is achieved with movement of the member relative to the rolls in a lengthwise direction of the member, while the member is in forced contact with each of the rolls.

6. A method according to claim 5 wherein said region of the member is driven between the rolls in the direction of the end of the member while the member and the rolls are rotated about each ones axis of rotation respectively, to thereby reduce the diameter of said region of the member and to form the thread.

7. A method according to claim 6 wherein the axes of rotation of the rolls are substantially parallel to the axis of rotation of the member.

8. A method according to any one of claims 1 to 7 wherein the member is a deformed bar having raised deformations formed along said region of the bar.

9. A method according to any one of claims 1 to 8 wherein crests of the thread formed are truncated.

10. A bar with an external thread formed along a region of the bar by a method as defined in any one of claims 1 to 9.

11. A roll for reducing a diameter of a region of an elongate member and for subsequently rolling an external thread onto the region of reduced diameter so formed, the roll having a first end and an opposite second end, and:

a tapered region with a circumferentially extending outer surface for contact with the member, and which has a diameter that increases in a direction from the first end of the roll toward to the opposite second end of the roll;

a thread forming region for forming the thread on the region of reduced diameter of the member, and

a section that spaces the tapered region from the thread forming region.

12. A roll according to claim 11 wherein said section of the roll has a diameter that is substantially the same as the largest diameter of the tapered region of the roll.

13. A roll according to claim 12 wherein said section of the roll is cylindrical and the diameter of said section is substantially constant.

14. An arrangement for reducing a diameter of a region of an elongate member and for rolling an external thread onto the region of reduced diameter so formed, comprising:

a plurality of rolls each having a first end and an opposite second end and being rotatable about an axis of rotation, respectively;

wherein the rolls are spaced apart to allow passage of the member between and alongside the rolls in a lengthwise direction of the member, and each roll has:

a tapered region with a circumferentially extending outer surface for contact with the member, and which has a diameter that increases in a direction from the first end of the roll toward to the opposite second end of the roll;

a thread forming region for forming the thread on the region of reduced diameter of the member, and

a middle section that spaces the tapered region from the thread forming region.

15. An arrangement according to claim 14 wherein the section of each said roll is cylindrical and the diameter of said section is substantially constant.

16. An arrangement according to claim 15 wherein said section of each said roll has a diameter that is substantially the same as the largest said outer diameter of the tapered region of the roll.

17. An arrangement according to any one of claims 14 to 16 wherein the axes of rotation of the rolls are substantially parallel with respect to each other.

18. A method of forming an external thread along a member, substantially as hereinbefore described with reference to any one of the accompanying drawings.

19. A member having an external thread formed along a member, substantially as hereinbefore described with reference to any one of the accompanying drawings.

20. A roll for use in forming an external thread along a member, substantially as hereinbefore described with reference to fig. 1.

21. An arrangement for forming an external thread along a member, substantially as hereinbefore described with reference to fig. 1.

FIG. 1.

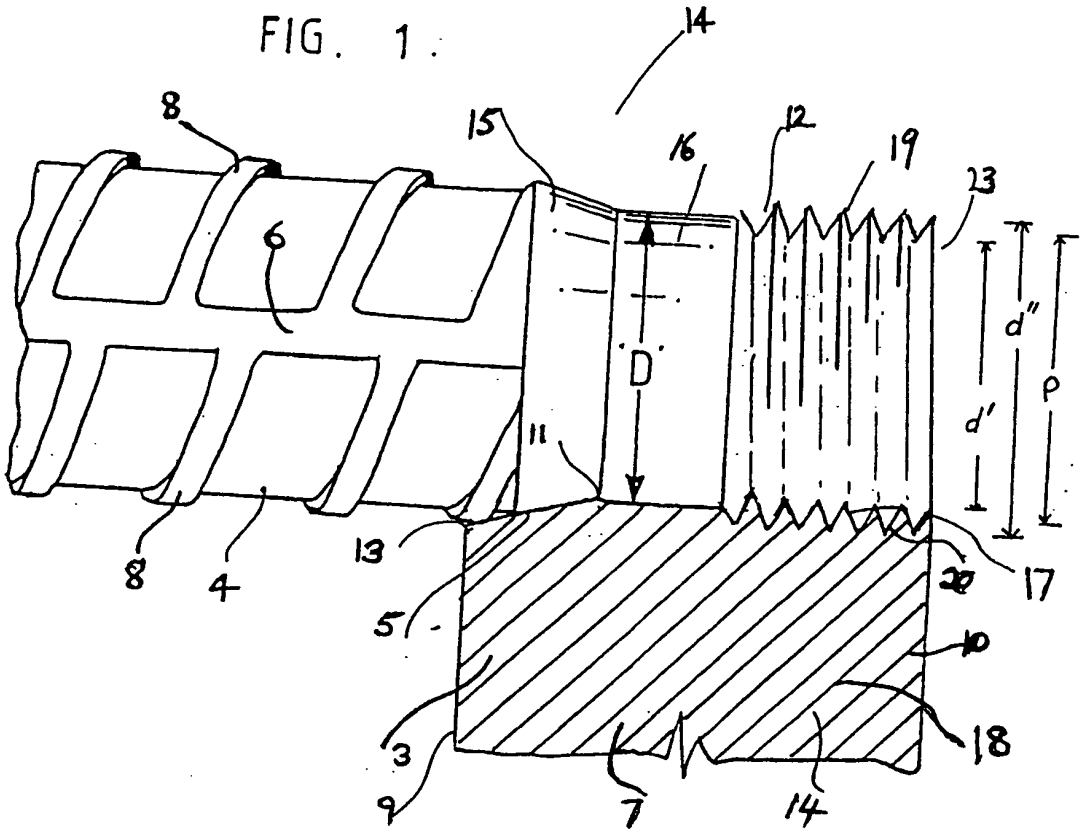
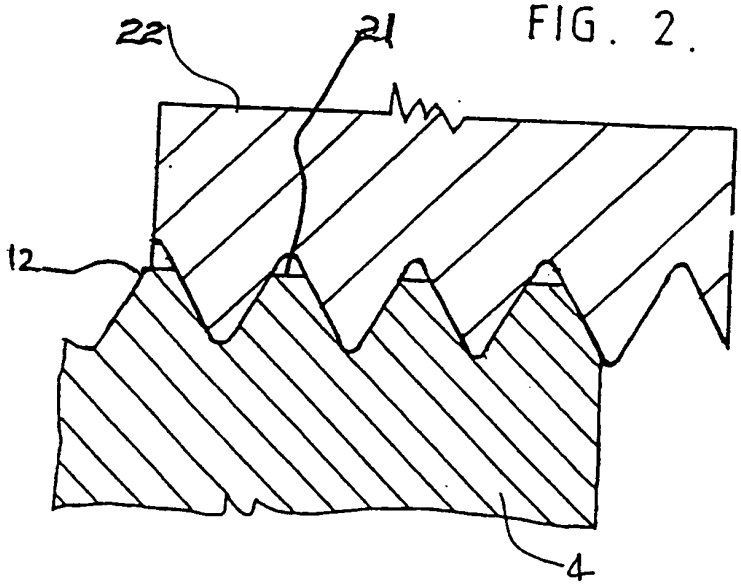


FIG. 2.



INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU 00/00081

A. CLASSIFICATION OF SUBJECT MATTER

Int Cl[7]: B21H 003/02, 003/04, 003/06

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC: B21H 003/02, 003/04, 003/06

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
AU: IPC as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5743123 A (YAMAMOTO et al) 28 April 1998 See Figure 1	1-3,11
A	AU 74446/81 A (THE TITAN MANUFACTURING CO PTY LTD) 25 February 1982 See Figure 1	1-21
A	EP 947642 A (CHUNG, Gyeng Ok) 6 October 1999 See Figure 1E	1-21

☐ Further documents are listed in the continuation of Box C

☒ See patent family annex

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Date of the actual completion of the international search	Date of mailing of the international search report
22 March 2000	- 9 MAY 2000

Name and mailing address of the ISA/AU	Authorized officer
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/AU 00/00081

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member					
US	5743123	CA	2195921	FR	2744383	JP	9206868
AU	74446/81	FR	2488820	FR	2530708	NZ	198090
EP	947642	AU	22574/99	CN	1239172	JP	11342448

END OF ANNEX